IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

In re Application of: **Pavel, et al.**	§	Serial No.: **10/776,672**
Filed: **February 11, 2004**	§	Confirmation No.: **3482**
Docket No.: **APPM/7608**	§	Group Art Unit: **1765**
For: **Method And Apparatus For Performing Hydrogen Optical Emission Endpoint Detection For Photoresist Strip And Residual Removal**	§	Examiner: **Tran, Binh X.**

MAIL STOP APPEAL BRIEF - PATENTS
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

APPEAL BRIEF

Further to the Notice of Appeal filed May 21, 2007, the Appellants submit this Appeal Brief to the Board of Patent Appeals and Interferences on appeal from the decision of the Examiner of Group Art Unit 1765 dated February 21, 2007, finally rejecting claims 1, 2, 6, 7, 9, 14, 16, 17, 21, 22, 28 and 30-45.

The Appellants believe that a $500 Appeal Brief fee is due in connection with this response. The Commissioner is hereby authorized to charge counsel's Deposit Account No. 50-3562 for this fee, and for any other fees, including extension of time fees, required to make this response timely and acceptable to the Office.

REAL PARTY IN INTEREST

The real party in interest is Applied Materials, Inc., located in Santa Clara, California.

RELATED APPEALS AND INTERFERENCES

The Appellants know of no related appeal and/or interference that may directly affect or be directly effected by or have a bearing on the Board's decision in the pending appeal.

STATUS OF CLAIMS

Claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 are pending in the application. Claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 stand rejected as discussed below. Claims 3-5, 8, 10-13, 15, 18-20, 23-27 and 29 have been cancelled. The rejections of claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 as set forth in the Final Office Action dated February 21, 2007 are appealed. The pending appealed claims are shown in the attached Appendix.

STATUS OF AMENDMENTS

No amendments to the claims were submitted in this application subsequent to final rejection.

SUMMARY OF CLAIMED SUBJECT MATTER

Embodiments of the present invention provide methods for processing semiconductor substrates using optical monitoring techniques. In the embodiment of independent claim 1, a method of removing a photoresist layer includes positioning a substrate comprising a photoresist layer into a processing chamber (*see, e.g.*, Fig. 3, step 304); removing the photoresist layer using a plasma (*see, e.g.*, Fig. 3, step 306); monitoring the plasma for both a byproduct optical emission and a reagent optical emission during the process (*see, e.g.*, Fig. 3, step 308); and stopping the etching upon the byproduct optical emission obtaining a first level and the reagent optical emission obtaining a second level (*see, e.g.*, Fig. 3, step 310). (Specification, ¶¶[0022]-[0027]; Fig. 3.)

In the embodiment of independent claim 16, a method of etching a photoresist layer includes providing a substrate comprising a photoresist layer to a process chamber (*see, e.g.*, Fig. 3, step 304); etching the photoresist layer using a plasma (*see, e.g.*, Fig. 3, step 306); and monitoring the plasma for both a byproduct optical emission and a reagent optical emission while etching (*see, e.g.*, Fig. 3, step 308). (Specification, ¶¶[0022]-[0027]; Fig. 3.)

In the embodiment of independent claim 35, a method of etching a photoresist layer includes providing a substrate comprising a photoresist layer to a process chamber (*see, e.g.*, Fig. 3, step 304); etching the photoresist layer using a plasma (*see, e.g.*, Fig. 3, step 306); determining an early endpoint indicator by monitoring the plasma for a reagent optical emission while etching (*see, e.g.*, Fig. 3, steps 308, 310); and determining a final endpoint indicator by monitoring the plasma for a byproduct optical emission while etching (*see, e.g.*, Fig. 3, steps 308, 310). (Specification, ¶¶[0022]-[0027], [0039]; Fig. 3.)

GROUNDS OF REJECTION TO BE REVIEWED ON APPEAL

1. Claims 1, 7, 9, 16, 21-22 and 31-45 stand rejected under 35 USC §103 as being unpatentable over United States Patent Application Publication No. 2001/0027023, published October 4, 2001 to *Ishihara* (hereinafter *Ishihara*) in view of United States Patent Application Publication No. 2002/0135761, published September 26, 2002 by *Powell et al.* (hereinafter *Powell*).

2. Claims 2, 6, 14, and 17 stand rejected under 35 USC §103(a) as being unpatentable over *Ishihara* and *Powell* and further in view of United States Patent Application Publication 2002/0151156, published October 17, 2002 by *Hallock, et al.* (hereinafter *Hallock*).

3. Claims 28, 30 stand rejected under 35 USC §103(a) as being unpatentable over *Ishihara* and *Powell* and further in view of United States Patent No. 6,419,801, issued July 16, 2002 to *Smith, Jr. et al.* (hereinafter *Smith*).

ARGUMENT

1. §103 Claims 1, 7, 9, 16, 21-22 and 31-45

Claims 1, 7, 9, 16, 21-22 and 31-45 stand rejected under 35 USC §103 as being unpatentable over *Ishihara* in view of *Powell*. The Appellants disagree.

Independent claims 1, 16, and 35 recite limitations not taught or suggested by any permissible combination of the cited art. *Ishihara* discloses a method of etching an organic layer using a plasma formed from an oxygen-containing gas, a hydrogen-containing gas, and a fluorine-containing gas. (*Ishihara,* ¶ [0019].) The non-deteriorated portion of the organic layer is ashed using an oxygen plasma in a second step. (*Id.,* ¶ [0137].) A monitor may determine when the etching is complete by monitoring the "light emission caused by CO and H as products from the resist **or** by O from the added gases." (*Id.,* ¶ [0135] (emphasis added).)

As such, *Ishihara* teaches monitoring the plasma for emissions caused by products from the resist or by the added gases. However, and as admitted by the Examiner in the Advisory Action dated May 15, 2007, *Ishihara* fails to teach or suggest monitoring a plasma used for removing (claim 1) or etching (claims 16 and 35) a photoresist layer for both a byproduct optical emission and a reagent optical emission, as recited in independent claims 1, 16, and 35.

Powell generally discloses sampling gas outside a reaction chamber that has passed through the reaction chamber during a process. (*Powell,* ¶ [0006].) More specifically, *Powell* teaches that upon the gas passing out of the reaction chamber, the gas diffuses into an excitation chamber and is excited therein to emit radiation. (*Id.*) A plurality of wave bands of an emission spectrum is detected, and a process may be controlled based on the detected wave bands. (*Id.*)

However, *Powell* fails to teach or suggest monitoring a plasma in a process chamber used for removing or etching a photoresist layer. To the contrary, *Powell* teaches forming a second plasma external to the chamber and to any plasma formed therein (for example during a cleaning process as given in one example by *Powell*). Accordingly, *Powell* explicitly teaches to exclusively monitor gases contained in an exhaust flow emerging from a reaction chamber (*e.g.*, within a dedicated, external excitation chamber). As such, *Powell* fails to teach or suggest monitoring the plasma

[used to remove a photoresist] for both a byproduct optical emission and a reagent optical emission during the process, as recited in claims 1, 16, and 32. In fact, one portion of *Powell* cited by the Examiner clearly states that "…it has been observed that practicing aspects of the present invention yields better results than using a photodetector and filter combination to reads [sic] emissions through a window from a reactor chamber." (*Powell*, ¶[0030].) Thus, the combination of the teachings of *Powell* with *Ishihara* would yield, at the very least, an endpoint detection process that monitors process effluent by forming a plasma external to the process chamber, and not by forming a plasma to remove (or etch) a photoresist and optically monitoring that plasma. Therefore, a *prima facie* case of obviousness has not been established as the combination of the cited references fails to yield the limitations recited in the claims.

In the Detailed Action section and in the Response to Arguments section of the Final Office Action, as well as in the Advisory Action dated May 15, 2007, the Examiner asserts that *Powell* teaches to monitor the plasma for byproduct optical emission and reagent optical emission and further that Powell teaches to detect both early and final endpoints in a process. The Appellants disagree.

In addition to the discussion above with respect to the teaching of *Powell* regarding monitoring a process effluent externally to the chamber, all portions of *Powell* cited by the Examiner (specifically, ¶¶ [0030], [0036], [0041], [0051], [0053], and Figure 11) – while discussing various ways to externally monitor a process effluent – clearly fail to teach or suggest a modification to the teachings of *Ishihara* that would yield an etch process including monitoring the plasma formed in a process chamber to etch a photoresist and determining an early endpoint indicator by monitoring the plasma for a reagent optical emission while etching; and determining a final endpoint indicator by monitoring the plasma for a byproduct optical emission while etching, as recited in claim 35. Similar untaught limitations are recited in claims 42 and 43, depending from claim 1. Therefore, a *prima facie* case of obviousness has further not been established with respect to these claims as the combination of the cited references fails to yield the limitations recited in the claims.

In the Advisory Action dated May 15, 2007, the Examiner asserts that, with respect to Figure 11 of *Powell*, he interprets a peak appearing early in the cleaning

process as an early endpoint indicator and a peak that occurs later in the process as a final endpoint detection. However, the Examiners' interpretation is not consistent with the teachings of *Powell*. Specifically, Figure 11 of *Powell* describes a chamber clean process showing a transition in wall composition. (*Powell*, ¶[0051].) Multiple peaks occur at earlier points in the process, the second to last being a drop in CO at about 5:29 into the process. (*Id.*) The last peak is a plateau in the oxygen level. Powell teaches that the process can be seen to be reasonably complete at 11:59, 12:53, or 14.01. (*Id.*) Accordingly, the closest change in the emission spectrum that the Examiner contends to interpret as an early endpoint indicator occurs at a point less than halfway through the process. Thus, *Powell* clearly does not support the interpretation that the Examiner asserts in the Advisory action and clearly fails to teach or suggest the limitations recited in the claims.

With respect to claims 31, 33, and 39, the Examiner asserts that *Powell* teaches to determine the condition of the plasma source. However, the Appellants can find no teaching or suggestion of a determination of a condition of the plasma source in the cited portion of *Powell*. Therefore, a *prima facie* case of obviousness has further not been established with respect to these claims as the combination of the cited references fails to yield the limitations recited in the claims.

In the Advisory Action dated May 15, 2007, the Examiner contends that Figures 5-6, and 9-10, paragraphs 0028-0032, including change in emission spectrum (Fig 9) or the gas flow rate (Fig 10) of *Powell* teaches to determine the condition of the plasma source. The Appellants strongly disagree.

In particular, paragraphs 0028-0032 of *Powell*, which describe the graphs of Figures 5-6, are silent with respect to plasma sources, let alone determining the condition of the plasma source. Figure 9 of *Powell* discusses how saved data from a process can be later analyzed, but is also silent with respect to determining the condition of the plasma source. (*see, Powell*, ¶¶[0037]-[0038].) Figure 10 of *Powell* discusses determining the quantity of Fluorine in an exhaust stream collected from data where no plasma discharge was present in the process chamber. (*see, Id.*, ¶¶[0037]-[0038].) Accordingly, these portions of *Powell* discuss aspects unrelated to determining the condition of the plasma source.

With respect to claims 41, 44, and 45, the Examiner asserts that the teachings of *Powell* could be used to modify the process of Ishihara to meet the limitations recited in the claims. The Appellants disagree.

Powell teaches to monitor optical emissions from an external process effluent. In the portion relied upon by the Examiner, *Powell* provides a chamber clean process that may be monitored to determine when the chamber clean is complete – not whether a chamber clean is necessary to begin with. (*See Powell*, ¶¶[0051]-[0053].) Accordingly, if one were to modify *Ishihara* in view of *Powell*, the resultant process would be an independent chamber clean process run prior to or after the process of *Ishihara* during which optical emission monitoring of an external process effluent may be used to determine when the chamber clean process is complete. Such a process fails to teach or suggest removing (or etching) a photoresist layer using a plasma… and determining from at least one of the monitored optical emissions [of the photoresist etch or removal process] whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both, as recited in the claims. Therefore, a *prima facie* case of obviousness has further not been established with respect to claims 41, 44, and 45 as the combination of the cited references fails to yield the limitations recited in the claims.

Thus, independent claims 1, 16, and 35, and claims 7, 9, 21-22, 31-34 and 36-45, dependent thereon, are patentable over *Ishihara* in view of *Powell*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

2. §103 Claims 2, 6, 14, and 17

Claims 2, 6, 14, and 17 stand rejected under 35 USC §103(a) as being unpatentable over *Ishihara* and *Powell* and further in view of United States Patent Application Publication 2002/0151156, published October 17, 2002 by *Hallock, et al.* (hereinafter *Hallock*). The Appellants respectfully disagree.

The patentability of claims 1 and 16 over *Ishihara* and *Powell* is discussed above. *Hallock* discloses a method for removing a hardened crust on a photoresist after exposure an ion implantation process. However, like *Ishihara* and *Powell, Hallock* also fails to teach or suggest monitoring a plasma used for removing or etching a photoresist

layer for both a byproduct optical emission and a reagent optical emission, as recited in independent claims 1 and 16. As such, *Hallock* fails to teach or suggest a modification to the teachings of *Ishihara* and *Powell* that would result in the limitations recited in the claims. Therefore, a *prima facie* case of obviousness has not been established as the combination of the cited references fails to yield the limitations recited in the claims.

Thus, claims 2, 6, 14, and 17 are patentable over *Ishihara* in view of *Powell* and further in view of *Hallock*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

3. §103 Claims 28, 30

Claims 28, 30 stand rejected under 35 USC §103(a) as being unpatentable over *Ishihara* and *Powell* and further in view of United States Patent No. 6,419,801, issued July 16, 2002 to *Smith, Jr. et al.* (hereinafter *Smith*).

The patentability of claim 1 and 16 over *Ishihara* and *Powell* is discussed above. *Smith* discloses monitoring a range of aspects of plasma processing operations. However, like *Ishihara* and *Powell, Smith* also fails to teach or suggest monitoring a plasma used for removing or etching a photoresist layer for both a byproduct optical emission and a reagent optical emission, as recited in independent claims 1 and 16. As such, *Smith* fails to teach or suggest a modification to the teachings of *Ishihara* and *Powell* that would result in the limitations recited in the claims. Therefore, a *prima facie* case of obviousness has not been established as the combination of the cited references fails to yield the limitations recited in the claims.

Thus, claims 28 and 30 are patentable over *Ishihara* in view of *Powell* and further in view of *Smith*. Accordingly, the Appellants respectfully request that the rejection be withdrawn and the claims allowed.

CONCLUSION

For the reasons advanced above, Appellants respectfully urge that the rejections of claims 1-2, 6-7, 9, 14, 16-17, 21-22, 28, and 30-45 as being unpatentable under 35 U.S.C. §103 are improper. Reversal of the rejections in this appeal is respectfully requested.

Respectfully submitted,

July 23, 2007

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CLAIMS APPENDIX

1. (Previously Presented) A method of removing a photoresist layer comprising:

positioning a substrate comprising a photoresist layer into a processing chamber;

removing the photoresist layer using a plasma;

monitoring the plasma for both a byproduct optical emission and a reagent optical emission during the process; and

stopping the etching upon the byproduct optical emission obtaining a first level and the reagent optical emission obtaining a second level.

2. (Original) The method of claim 1 wherein the photoresist layer comprises a hardened crust layer.

3-5. (Cancelled)

6. (Previously Presented) The method of claim 2, wherein the monitoring step produces signals having first levels while etching the crust and produces signals having second levels after the crust has been removed.

7. (Previously Presented) The method of claim 1, wherein the byproduct is hydrogen and the hydrogen optical emission occurs at a wavelength of about 656 nm.

8. (Cancelled)

9. (Previously Presented) The method of claim 1, wherein the reagent is oxygen and the oxygen optical emission occurs at a wavelength of about 777 nm.

10-13. (Cancelled)

14. (Previously Presented) The method of claim 6, wherein the monitoring step produces signals having a third level after the photoresist is removed.

15. (Cancelled)

16. (Previously Presented) A method of etching a photoresist layer comprising:
providing a substrate comprising a photoresist layer to a process chamber;
etching the photoresist layer using a plasma; and
monitoring the plasma for both a byproduct optical emission and a reagent optical emission while etching.

17. (Original) The method of claim 16 wherein the photoresist layer comprises a crust.

18-20. (Cancelled)

21. (Previously Presented) The method of claim 16, wherein the byproduct is hydrogen and the hydrogen optical emission occurs at a wavelength of about 656 nm.

22. (Previously Presented) The method of claim 16, wherein the reagent is oxygen and the oxygen optical emission occurs at a wavelength of about 777 nm.

23-27. (Cancelled)

28. (Previously Presented) The method of claim 1, further comprising:
comparing the monitored optical emissions to a fingerprint of a clean chamber.

29. (Cancelled)

30. (Previously Presented) The method of claim 16, further comprising:
comparing the monitored optical emissions to a fingerprint of a clean chamber.

31. (Previously Presented) The method of claim 16, further comprising:
determining the condition of a plasma source.

32. (Previously Presented) The method of claim 16 further comprising:
determining the condition of an inner surface of the processing chamber.

33. (Previously Presented) The method of claim 1, further comprising:
determining the condition of a plasma source.

34. (Previously Presented) The method of claim 1, further comprising:
determining the condition of an inner surface of the processing chamber.

35. (Previously Presented) A method of etching a photoresist layer comprising:
providing a substrate comprising a photoresist layer to a process chamber;
etching the photoresist layer using a plasma;
determining an early endpoint indicator by monitoring the plasma for a reagent optical emission while etching; and
determining a final endpoint indicator by monitoring the plasma for a byproduct optical emission while etching.

36. (Previously Presented) The method of claim 35, wherein the determining a final endpoint indicator step further comprises:
monitoring the plasma for a hydrogen optical emission while etching.

37. (Previously Presented) The method of claim 36, wherein the determining an early endpoint indicator step further comprises:
monitoring the plasma for an oxygen optical emission while etching.

38. (Previously Presented) The method of claim 35, wherein the determining an early endpoint indicator step further comprises:
monitoring the plasma for an oxygen optical emission while etching.

39. (Previously Presented) The method of claim 35 further comprising:
determining the condition of a plasma source.

40. (Previously Presented) The method of claim 35, further comprising:

determining the condition of an inner surface of the processing chamber.

41. (Previously Presented) The method of claim 1, further comprising:

determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.

42. (Previously Presented) The method of claim 1, wherein the monitoring step further comprises:

determining an early endpoint indicator from the reagent optical emission.

43. (Previously Presented) The method of claim 1, wherein the monitoring step further comprises:

determining a final endpoint indicator from the byproduct optical emission.

44. (Previously Presented) The method of claim 16, further comprising:

determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.

45. (Previously Presented) The method of claim 35, further comprising:

determining from at least one of the monitored optical emissions whether a cleaning cycle is necessary, whether components within the chamber are degrading, or both.

EVIDENCE APPENDIX

[NONE]

RELATED PROCEEDINGS APPENDIX

[NONE]